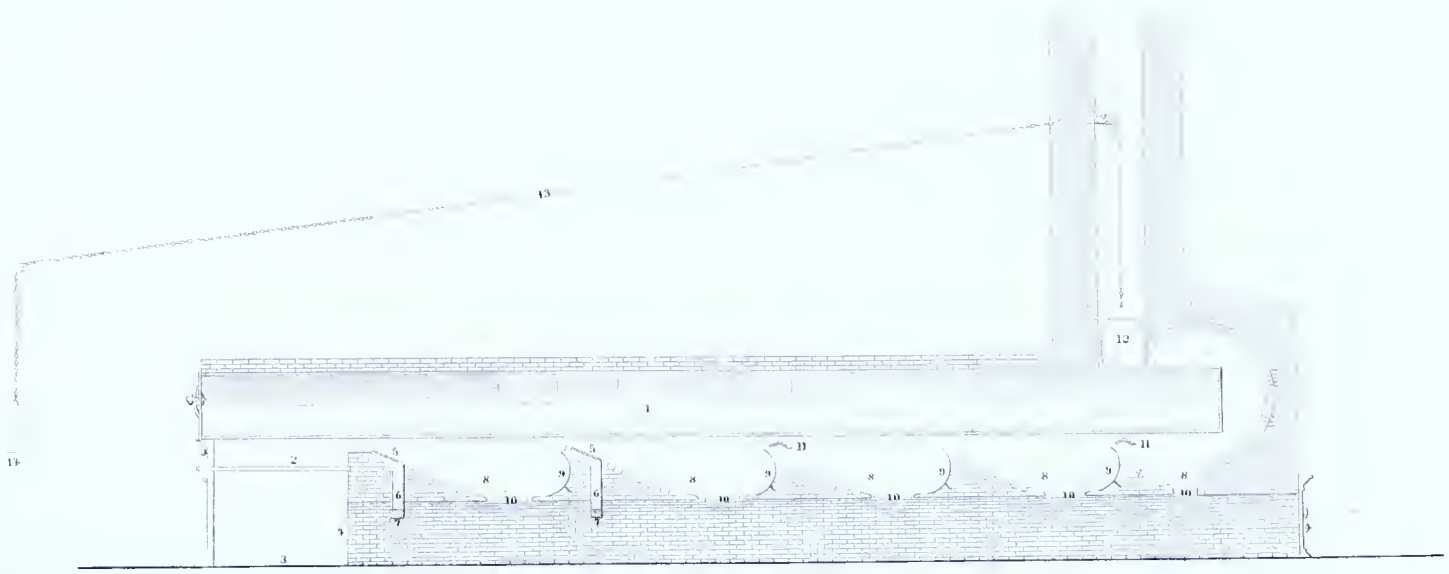

IMPROVEMENT IN STEAM BOILER FURNACES,

BY

HENRY F. BAKER, BOSTON, MASS.

Patented, May 30th 1846.

Scale ½ inch to a foot.

REFERENCES TO THE PLATE.

1. Boiler, 36 feet in length, 30 inches in diameter.
2. Fire Grate, 5 feet 6 inches in depth.
3. Ash Pit.
4. Entrances to Arched Passage, under the Furnace.
5. Perforated Plates for fresh Oxygen.
6. Air Tubes for its admission.
7. Regulators for the same.
8. Chambers or Retorts for consuming the Gas and deflecting the flame upward to the Boiler.
9. Reverberatory Iron Plates.
10. Open Grates, or intervals for ashes and dust falling into the arched passage below.
11. Throat, or flues to divide the flame.
12. Damper in the Stack of the Chimney.
13. Chain and Wheel Regulator to the same.
14. The Balance Weight.

IMPROVEMENT

IN

STEAM BOILER FURNACES,

BY HENRY F. BAKER, OF BOSTON, MASSACHUSETTS.

PATENTED, 30TH MAY, 1846.

In submitting the following pages to the Manufacturing community, the writer claims nothing more than the simple merit of combining some of the common principles of natural science, without reference to any one of the alleged improvements, which have been offered to the public, as Improved Furnaces for Steam Boilers. Devoted for many years to commercial pursuits, he was unfamiliar with the details of Steam operations, until after having projected the plan of the Steam Flour Mill at East Boston, and been entrusted with its management, he felt himself compelled to direct his attention to the thorough investigation of the principles, and the practical application of Steam Power, with reference to the Engine, the Boiler, and the Furnace. In pursuing this investigation, he discovered, as he supposed, a great want of economy in the construction of Furnaces, and a consequent waste of Fuel. By the kindness of the Chief of the Bureau of Navy Yards and Docks at Washington, permission was granted to him, to make

experimental trials at the Dry Dock, at the Navy Yard in Charlestown, and the *principle* having been fully ascertained to be correct, such modifications were introduced, as to render it more effective, in subsequent trials. An application was shortly afterward made for a Patent, and, in due course, it was granted, on the 30th May, 1846.

The principles, upon which this improvement in Steam Boiler Furnaces is founded, are *slow combustion, radiation of heat reflexively,* and *its retention under the Boilers, until its active power is exhausted.*

Combined with these correlative operations, the gaseous portions of the Coal are also consumed, and although this latter process was introduced by Charles Wye Williams, Esq., of Liverpool, in 1842, yet it has never been brought into action, in the manner now proposed, and applied. By Mr. Williams's plan, the gaseous combustion commingled with the flame from the coals, and formed one united current, or volley of fire, which passed off to the stack, and much unconsumed gas escaped. An objection was therefore raised to Mr. Williams's plan, which diminished the merits of this invention in the opinion of some, who did not thoroughly examine the whole subject. There were discrepancies in the statements of those who had adopted it, and practically tested the "Argand Furnace," which requires great care and skill on the part of the Fireman in its management. If through ignorance of the principles of the invention, or carelessness in the management of the Air valve, the Fireman does not properly regulate the supply of air, the apparatus may prove injurious, instead of beneficial. If too little air is admitted,

part of the gases will pass off unconsumed—if too much, then, although there may be perfect combustion, without smoke, the superabundant air passing through the flues to the chimney reduces the temperature of the whole, and consequently causes a waste of fuel.

In the improved Furnace, now under consideration, this difficulty is wholly obviated, as too much air cannot be drawn into the flue, while the ordinary supply of coal is upon the Grates, or the Fireman is attending to his ordinary duty.

By the introduction of the semi-elliptical chambers or retorts, the gas in the improved Furnace is ignited at the upper edge of the plates, at the mouth of the retorts, and forming an independent current of flame, encircles the lower periphery of the Boilers, from ten to fifteen feet distant from the fire wall, while the fire from the coals is impelled into the main body of the chambers, and meeting the curved plate at each successive interval, is reverberated upward and backward, until by its concentration, it is crowded forward into each successive chamber; and thence is permitted to escape through the narrow aperture, which the damper regulates, at the end of the Boilers. As the volatile products of the coal form the upper volume of flame, the main body of fire in its reverberatory progress, is constantly commingling with, or intersecting the gaseous flame; of course the temperature of the unconsumed gas is kept up to such a degree, that it must remain combustible, until it is wholly consumed, and hence a material economy in this arrangement.

In an ordinary Furnace, the flame leaves the fire

bars, and is impelled, straitly and quickly to the stack, where it is supposed, more than one half of the heat ascends into the upper atmosphere, and is lost. The Boilers thus receive only the *lateral heat* of the flame, and the heated atmosphere of the area beneath them. The apex of the flame takes its forward course, and goes into the chimney, and from the top of the stack, we have constant evidence, there is more lost, than is retained for its intended use. If we take a piece of tissue paper, and make it into a cylindrical form, then place it around a lighted candle, the lateral heat of the flame will not ignite the paper in a still atmosphere, when it appears to be almost in contact; but at a distance of six or eight inches from the apex of that flame, it will be instantly consumed.

Now this principle is adopted in the improved Furnace: in which the apex of the flame is directed and controlled, carried upward by a reverberatory process, repeatedly, to the lower periphery of the Boilers, and by continuous application of these forks of flame, consumes all the oxygen, which can be advantageously brought into contact with the gas, or introduced into the Furnace.

There is, however, a general principle upon which this improvement rests, which is incontrovertible. The reflective powers of light, heat and sound, are found to be the greatest at an angle of 45°, whether semi-spherically or semi-elliptically, and the entire arrangement of this Furnace is based upon this law of natural science so familiar to any intelligent observer. If, then, it is found, that the practical application of

this general principle is attended with success in all cases, it is surely worthy of favorable consideration, although in the construction of furnaces, it may be but partially known, or adopted. It is worthy of remark, however, that wherever the principle has been explained, to any one of the large class of intelligent machinists and engineers throughout the country, practical and scientific, it has, in almost every instance, met with unqualified approval; and wherever it has been introduced, the certificates appended hereto, confirm the correctness of their opinions and judgment.

It would be useless to refer to the various plans and devices which have occupied the attention of so many theorists, and practical operators, in reference to the most economical use of fuel, the production of heat, and the generation of steam, in regard to Furnaces, Boilers and Steam Engines, during the last ten years; except to note the rapid advance, which has been made by the inventive genius of the age, and the wonderful accessions of practical and useful knowledge, the elements of which have been as familiar as sunlight, but the combinations of which are now subjects of daily developement.

In the present instance, it would be equally useless, to refer to the diversity of opinion, which even now exists, as to the best mode of constructing the furnace of a Steam Boiler. While some advocate, and adhere to, the principle of a strong blast from a fan blower, absorbing a considerable portion of the power created, to obtain a rapid draft, and attended with an incessant din, others maintain that of slow combustion by a steady fire,

thereby producing an increase of evaporation. But without entering into any argument on this point, it is here stated with a perfect conviction of its truth, derived from past experiments and observation, that in most of the manufacturing establishments of New England, requiring constant Steam Motive Power, and using Cylinder Boilers, a saving can be made, under their present arrangement and construction, of twenty-five per cent, of the quantity of fuel consumed, *independent* of a large increase of Motive Power ; and in a majority of cases, the advantages gained would be from 40 to 50 per cent. Introducing this principle to the notice of the Manufacturing community, it is expressly stated, that the improved Furnace will be offered on terms of mutual advantage, to the purchaser of the right. The cost of alteration and reconstruction is found to be about sixty-five dollars for each Boiler of thirty feet in length, but the price will be fixed at the actual cost.

HENRY F. BAKER, *Patentee.*

Boston, July 15, 1847.

The first experiment made upon this principle, after the preparatory trials at the Dry Dock, at the Navy Yard, Charlestown, was tested at the Cooperage of Charles A. Locke, Esq. His opinion is expressed in the following letter.

Boston, November 12, 1846.

Dear Sir :

In reply to your note of this date, I cheerfully state, that the improvements introduced under the Boilers at my Cooperage establishment in Charlestown,

have given me entire satisfaction, and I have no hesitancy in recommending your patented Furnaces to general use. After a trial of six months, I am perfectly satisfied with the result, from my own observation, as well as the experience of my engineers, and although I formerly stated to you, that the saving of fuel was fully thirty per cent, I now assure you that it has been ascertained to be much greater.

I would not mislead you or any other person, but after a careful examination of details, I am convinced, that in the economy of my establishment, I have procured by the introduction of your patented improvements a nett gain of forty per cent. in the cost of its motive power.

Respectfully yours,

CHARLES A. LOCKE.

In this instance, a trial was made under two boilers, 30 feet in length, one of 42 inches in diameter, the other 39 inches, and driving an engine, rated at thirty horse power. The fuel made use of was wet saw dust, chips, shavings, hoop poles, &c., and occasionally Pictou Coal. No opportunity of testing the amount of evaporation existed at the time of trial, nor could there then be given an accurate estimate of the quantity of fuel saved; but an experience of six months has furnished the requisite information on that point.

The next trial was made with peculiar care at the well known establishment of Messrs. Heywood and Carnes, in Charlestown, in order to test the amount of evaporation, as well as the relative consumption of fuel. In this well conducted establishment, there are four

boilers, 30 feet in length, and 30 inches in diameter driving an engine of 50 horse power, which is steadily used during the working hours of the day.

In the preparatory trial of three days, during which the ordinary work of the manufactory was accomplished, 12,336 lbs. of Anthracite Coal were consumed, and 10,032 gallons of water thereby evaporated, being $6\frac{794}{1000}$ lbs. of water evaporated from one pound of coal, or from a temperature of 212°, equivalent to $7\frac{367}{1000}$ lbs. per pound used.

In the following week, the Furnaces were remodelled under the improvement, and shortly afterward subjected to a similar trial of three days, with the same coal, and no diminution of motive power. The result was, a consumption of 9,433 lbs. of Anthracite Coal to evaporate 11,989 gallons of water, during the same period of working time, as in the former experiment, being $10\frac{62}{100}$ lbs. to a pound of coal from its initial temperature, or $11\frac{515}{1000}$ from a temperature of 212°. After the experiment was completed, it was ascertained by exact measurement, that the Water Tank contained 1,090 gallons of water instead of 1,056, as had been computed, and this correction makes the amount of evaporation $11\frac{89}{100}$ lbs. per pound of coal consumed.

After a trial of three months, the following note was handed to me.

CHARLESTOWN STEAM MILLS.

November 12, 1846.

DEAR SIR :

In reply to your note of this date, we have to state, that the alterations made under our four boilers, have given us entire satisfaction, and we readily furnish

you with our assurance of the entire confidence, which we have, in the value of your patented improvement, after a fair trial of nearly three months.

The Certificate, which we gave to you in August, after the experimental trial, supersedes the necessity of our adding any other testimonial. It may, however, be a matter of satisfaction to you to know, that after a careful inspection of the Furnace, a few days since, the whole of its interior construction was found perfect, and uninjured, and of course it has passed its ordeal of fire.

Respectfully yours,

HEYWOOD & CARNES.

In connection with this note, it is only necessary to add, that the intelligent engineer of this establishment, has certified, that "the amount of evaporation is greater in proportion to the quantity of coal consumed now, than it was during the test trial, and in that period there was never less than forty horse power used, during the eleven working hours." The tabular statements of these trials were submitted to A. A. Hayes, Esq., of the Chemical Works at Roxbury, and he has appended thereto the following note.

"The comparison between Furnaces of different forms, applied to the same boilers, working under the same pressure, being made on the fuel, is correctly estimated by the comparative evaporation of water."

A. A. HAYES.

Roxbury Laboratory, 31*st August*, 1846.

Hence it appears, that the gain in motive power by evaporation, was in the proportion of 7,367 to 11,515

or $56\frac{1}{4}$ per cent., being the difference between the first and second trials.

In the experimental trial made at the Dry Dock, at the Navy Yard in Charlestown in December, 1845, by the permission of the Chief of the Bureau on Docks, &c., under two Boilers of 26 feet in length, and 30 inches in diameter, and driving an engine of 50 horse power, under a pressure of 75 lbs. of steam, $6\frac{477}{1000}$ lbs. of water were evaporated per pound of Anthracite Coal, used during the week of regular work in that establishment. Shortly afterwards, *one* of the reverberatory arrangements, with brick work, and soap stone, was introduced under the same boilers, and the result of another week's trial gave $7\frac{539}{1000}$ lbs. of water evaporated as before, or 16 per cent. gained in motive power under a like pressure of steam.*

The improved Furnace has also been introduced into the Print Works of Mess. Robert Schouler & Brother, at West Cambridge, and the following certificate has been furnished by those gentlemen.

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* Note. Abstract from minutes of the two trials.

1845.

December 15 to 20. 13140 lbs. of Anthracite Coal used in six days, evaporating 8794 3-4 gallons of water, the temperature being 49° F., and steam pressure 75 lbs. Thermometer 35°, mean at M.

1846.

January 19 to 24. 12250 lbs. of Anthracite Coal, used in six days, evaporating 9520 gallons of water, the temperature being 47° F., and steam pressure 75 lbs. Thermometer 22°, mean at M.

And are certified by

NOAH BUTTS, *Engineer, Navy Yard, Charlestown.*

West Cambridge, Nov. 20, 1846.

We hereby certify that we have introduced into our Print Works, "the improvement in Steam Boiler Furnaces, patented by Henry F. Baker, of Boston." And that after a fair trial, and use of the same, we are satisfied, that we are making a saving of forty per cent in the consumption of fuel, and a large gain in the amount of evaporation. The draught through the flue is perfect, and the smoke from the chimney rarely perceptible.

ROBERT SCHOULER AND BROTHER.

The next trial was made at the York Manufacturing Company's establishment at Saco, and with what success, General Boyd's letter will most clearly explain.

Saco, March 23, 1847.

Dear Sir:

Mr. White called on me a few minutes since to make some enquiries relative to the Boiler, which was set for the Company, the past winter on your plan, patented some time last season.

The Boiler is not used for motive power, but simply for heating one of our Mills. Before he set the Boiler on your plan, we had two upright Boilers, one at each end of the Mill, from which we could not generate Steam sufficient to warm the Mill at all times. When Mr. W. set your Boiler, we removed one of the old Boilers, and left the other, but have not used it but very little, the past winter, for the reason, that we got Steam sufficient from the one which Mr. White set. The Coal consumed under the new Boiler is not as

much as under one of the old Boilers. In fact, we have not wanted for Steam in the coldest weather this winter, whereas with the two old Boilers, we could not get a supply.

Respectfully yours,

A. H. BOYD,

Agent York Manufacturing Company.

The next trial was made at the Eagle Furnace in Albany, an establishment of long standing, and extensive in its operations and celebrity. From its proprietors, the following letter has just been received.

ALBANY, July 1, 1847.

DEAR SIR :

It is several months since our Boiler was set over your Patent Furnace, and we are convinced that the saving over those set on the ordinary plan is very considerable. The following is the result of a trial as calculated and managed by a competent person, in whom we have confidence.

Coarse Lackawana Coal - - -	777 lbs.
2109 lbs. Fine Dust and Refuse Coal, say equal to Coarse, - - -	1059 lbs.
13 hours Working time	——
	1836 lbs.

The amount of Water used was $13\frac{7}{8}$ inches in depth drawn from a cistern, 20 feet in diameter, or 2717 gallons = 22,702 lbs. The temperature, estimated at 110° F. and gives an evaporation of $12,\frac{730}{1000}$ lbs. per pound of Coal used, or from 212°.—$13,\frac{769}{1000}$ lbs.

Your friends,

JAGGER, TREADWELL & PERRY.

The Boiler used in the above experiment was 42 feet in length, and 38 inches in diameter, driving two Engines, one of twelve, the other twenty horse power, by which all their extensive works were kept in operation, and from eight to ten tons of Iron melted daily, and all done at an expense of about three dollars per day.

As no trial had been made in an extensive Cotton Manufacturing Establishment, it was deemed desirable to try an experiment at the Portsmouth Cotton Mills recently erected, and under the superintendence of an intelligent Agent. The experiments were conducted under the direction of Doct. Charles T. Jackson, of this city, and his report follows.

Report of comparative trials of six Cylindrical Steam Boilers, arranged in the ordinary manner, against the same number of similar Boilers, with Mr. H. F. Baker's Patent Furnaces.

The experiments were made on Tuesday and Wednesday 13th and 14th April and on Wednesday, Thursday and Friday 21st 22d and 23d April 1847, under the superintendence of Mr. Jos. S. Kendall, by my direction.

The Water Tank was carefully measured, and found to contain 2823 lbs. A pipe containing 100 lbs. of water was emptied with each tank, as stated below.

The quantity of coal, consumed in the experiments, was also weighed. The following results were obtained.

OLD STYLE OF FURNACES.

Tuesday, April 13.	Used 11 Tanks	water	2823 lbs.	each.		31,053 lbs.
Wednesday " 14.	" 14 do	do	"	"		39,522 "
Thursday " 22.	" 19 do	do	"	"		53,637 "
	44 Pipes		100	"		4,400 "
				Water evaporated		128,612 "

Coal consumed 1st day, 5500 lbs.
2d " 7306
3d " 9051
Total, 21857 lbs.

$\frac{128612}{21857} = 5{,}884$

It appears then, that by the Boilers and Furnaces, on the old plan, that each pound of coal evaporated $5,\frac{884}{\text{—}}$ lbs. of water.

BOILERS WITH PATENT FURNACES.

Tues. April 13.—used	14	Tanks	water,		39,522 lbs.
Wed. " 14.— "	18	"	do		50,814 "
" " 21.— "	23	"	do		64,929 "
Friday " 23.— "	27	"	do		76,221 "
	82 pipes	100 lbs.	ea.		8,200 "
					239,686 lbs.

Coal consumed.

1st day	5500 lbs.
2d "	6705 "
3d "	8295 "
4th "	9500 "
	30,000

$\frac{239,686}{30000} = 7.989$ lbs of water evaporated to one pound of Coal.

7.989	Boilers with Patent Furnace.
5,884	do " Old Style.
2,105	Difference.

5,884 : 2105 :: 100 : X = $35\frac{7}{10}$, which is the per centage gain of the evaporation of Patent Furnaces.

By the Engineer's Indicator, observed on the 13th April, the power on the Cylinder, when the Boilers over the common Furnaces were used, was $49\frac{1}{2}$ Horse power, while that on the same engine, while connected with the Boilers over the Patent Furnaces was 90 Horse power.

90
49^2
—-
40^2 difference in favor of patent Furnaces.

$49^2 : 40 :: 100 : X = 81.\frac{818}{---}$ per centage gain in Horse power by the Patent Furnace.

The above experiments were made in the presence of the Agents and Engineers of the Mills, and Mr. I. S. Kendall, and Mr. White, and who observed the experiments, and their results.

Respectfully,
Your most ob't serv't,
CHARLES T. JACKSON.

The temperature of the Water in the Tanks, was 148° F. in all the experiments, made at the Portsmouth Steam Mills. C. T. JACKSON.

An experimental trial, not yet concluded, has also been made at the Ocean Mills, in Newburyport, upon five cylindrical Boilers, driving an engine of one hundred Horse Power, three days, with Boilers over the Improved Furnace, and three days with similar Boilers over furnaces of a construction hitherto considered the best.

The result, so far, is decidedly in favor of the Improved Furnace, and the end will undoubtedly justify the first result.

A considerable number of Furnaces, on the improved plan, have been erected in various places, but as they are all new establishments, no comparative certificates can be furnished; and in other places where alterations and reconstructions have been made, the previous arrangements under the old system were so defective, that a gain of 50 or 60 per cent. would not equal those of 40 per cent. heretofore stated. So much depends upon the length of the Boiler, the kind and size of grate, the mode of firing, the area and elevation of the chimney, the quality of the water used, and the situation of the building, that no two apparently similar Boilers will produce like results in different places.

Hence the great inequality in the amount of evaporation, varying with the Improved Furnace from 9 to $13\frac{3}{4}$ lbs. of Water per pound of Coal; against the usual average of 6 pounds, with the ordinary furnaces. In the case of Messrs Heywood and Carnes's experiment, their evaporation was one of the highest then met with, being $7.\overline{367}$ lbs. under their old furnaces and $11.\overline{515}$ under the Improved; while at the Eagle Furnace at Albany, $13.\overline{769}$ was obtained. At the Portsmouth Mills, the evaporation under their former arrangement was $6.\overline{250}$ lbs. while the power was $49\frac{1}{2}$ h. p.,—but under the improved Furnace the evaporation was 8.485 and the power 90, making a gain of $35\frac{7}{10}$ per cent. in evaporation, and $81.\overline{819}$ per cent. gain in horse power, over the common furnace.

All further trials have now terminated, and as experiments have been made upon every description of fuel, from wet sawdust, shavings and chips, to solid wood, and from the dirt of dust Coal to the highest grade of Anthracite, uniformly attended with equal results, in regard to the economy, or saving of the fuel, and increase of evaporation, the merits of the Improved Furnace are established on these points, viz.: that any description of fuel can be used in these furnaces, with equal advantage, or per centage of saving, and that the gain in evaporation is from two to four pounds of water, per pound of coal consumed.

To the Planters of Louisiana, the Proprietors of Steamboats on the Western Waters, and the owners of Saw Mills, and other Manufacturing Establishments, this Improvement is especially recommended. Having been thoroughly investigated in its principles, and personally examined as to its practical operation, by a distinguished planter of Louisiana, it has been confidently recommended by him, for the purposes above enumerated.

It is estimated, that there are at least 800 Sugar Plantations, 1000 Steamboats, and 500 Saw Mills, and other establishments, on the Mississippi and Ohio Rivers, where this improvement might be most advantageously introduced; saving from 25 to 40 per cent in the cost of motive power; and in relation to Steamboats, taking into view the delay, occasioned by "wooding," the space occupied, and other familiar circumstances, the saving would be much greater.

With these simple statements, the Patentee has only

to inform the manufacturing community, that any information, which may be desired in regard to the Patent, can be obtained from John O. Sargent, and A. J. Willard, Esquires, No. 11 Wall street, New York, William Dehon Esq. No. 39 Court street, Boston, or of the Patentee,

HENRY F. BAKER,
No. 17 Doane street.

Boston, July 15, 1847.

Wright's Steam Press, 3 Water Street.